AUGUST 2019

WIM #34
MN 23, MP 122.1
CLARA CITY, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #34 is located on MN 23 near Clara City in Chippewa county.

System Operation

WIM #34 was operational for the entire month of August 2019. Volume was computed using all monthly data.

System Calibration

WIM #34 was most recently calibrated on 2019-05-16. Table 1 summarizes the front axle weights of class 9s by lane [1]. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation [2]. Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 122829 | Passenger Vehicles: 105743 | Heavy Commercial Vehicles: 17086

Monthly Average Daily Traffic (MADT): 3935 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 551

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. NB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Tuesdays. SB vehicles typically reached highest volume levels on Sundays, with lowest volumes reported on Tuesdays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), NB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, SB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 03 PM and 05 PM, while volume going SB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 5's.

Overweight HCVs

Volume trends. Of a total of 17086 HCVs, 2664 of them were overweight [3]. These overweight HCVs contributed to 2.2% of total monthly volume, and 15.8% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on Saturdays. SB overweight vehicles tended to reach highest volumes on Mondays, with lowest volumes reported on Saturdays. See Figure 3 . The top two overweight violators by class were the class 9 and class 10 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 50.5% of all overweight vehicles traveling NB this month (see Figure 7 & 8). Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in June.
WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report [4].
Using normal load limits ,163 NB vehicles exceeded 88,000 pounds (81 vehicles were Class 13's; 52 vehicles were Class 10's). Of vehicles traveling SB,

181 NB vehicles exceeded 88,000 pounds (72 vehicles were Class 13's; 53 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from August 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in August 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling NB, while there were more fully_loaded Class 9's than empty traveling SB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the NB direction. In the SB direction, there were more empty class 10 vehicles.

Freight Totals. A total of 145695 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (52.2%) than NB (47.8%). See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 12012 is approximately 3.8 miles north of WIM #34, and Bridge No. 12004 is 3.1 miles south of WIM #34. WIM #34 recorded a total of 122829 vehicles with a combined GVW of 1292731 kips (1 kip = 1,000 pounds = 0.5 tons) in August 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 15040 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 51% of all ESALs were recorded SB while 49% was observed NB. In particular, 64% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 38% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

#####WIM monthly reports can be found at:
http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html MnDOT's vehicle

classification scheme and vehicle class groupings for traffic forecasting can be found at: http://www.dot.state.mn.us/traffic/data/data-products.html#weight

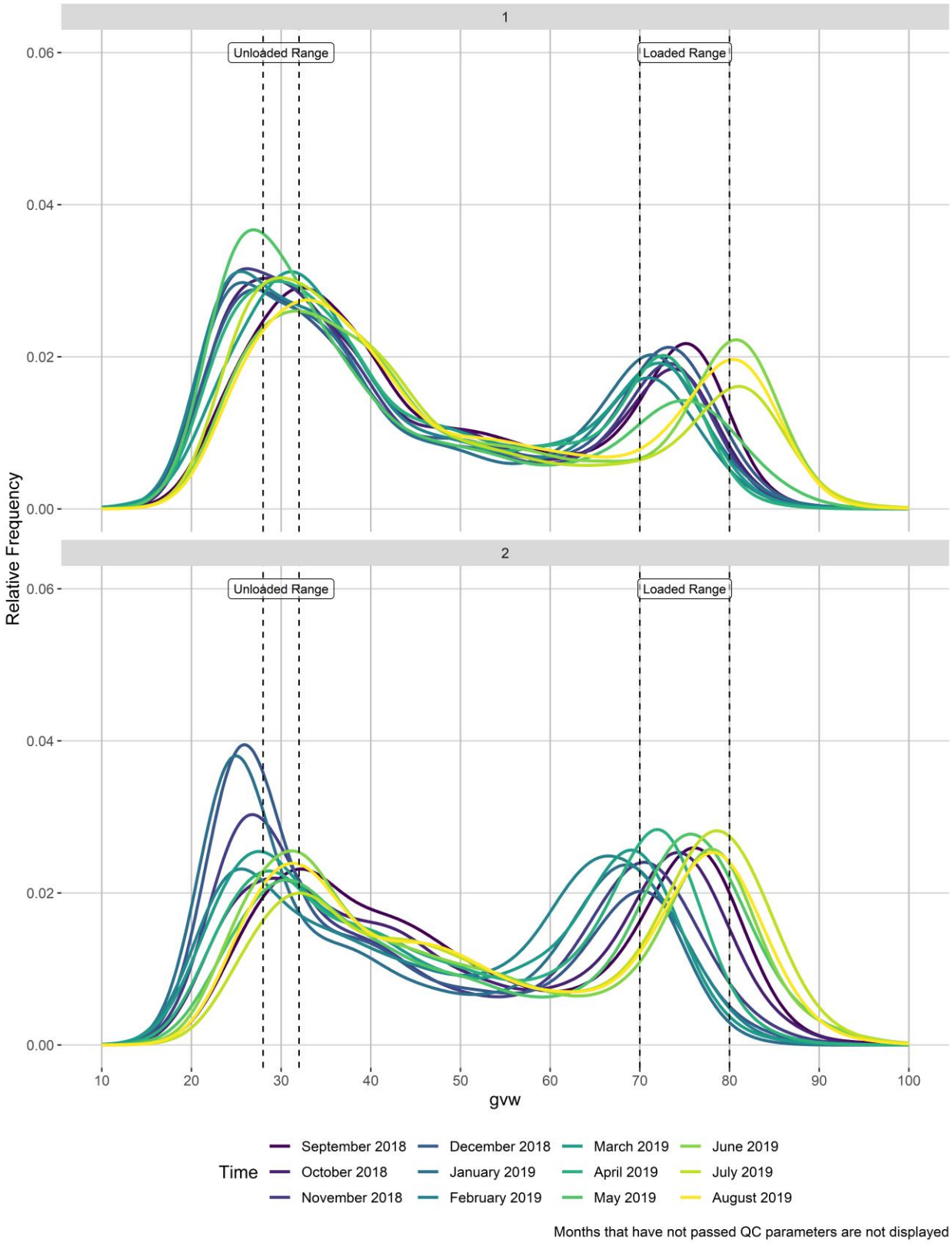
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [2] Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.

- [3] An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp

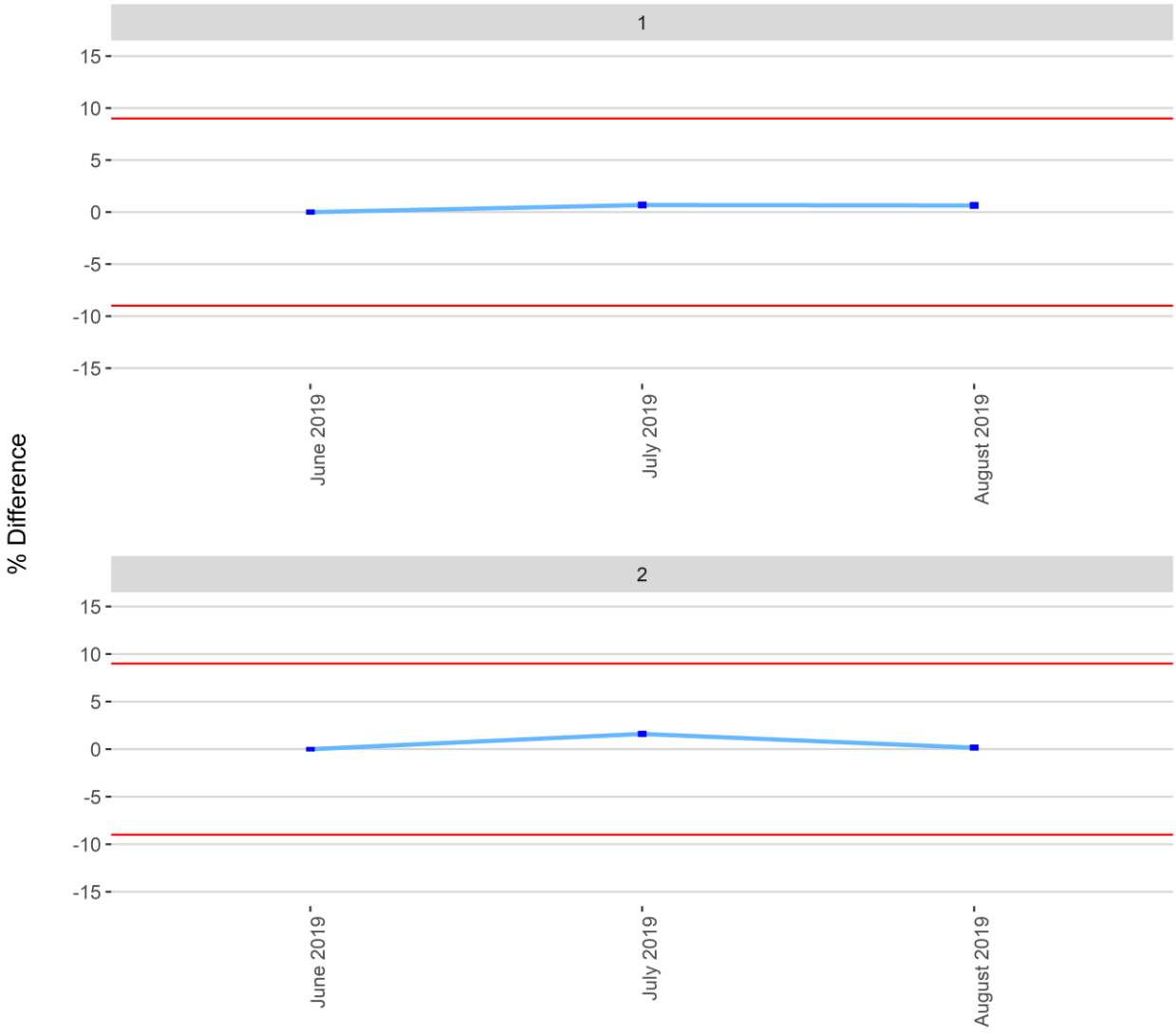
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

Figure 1 - Monthly Class 9 GVW Histogram



Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume
vs. Day of the Week

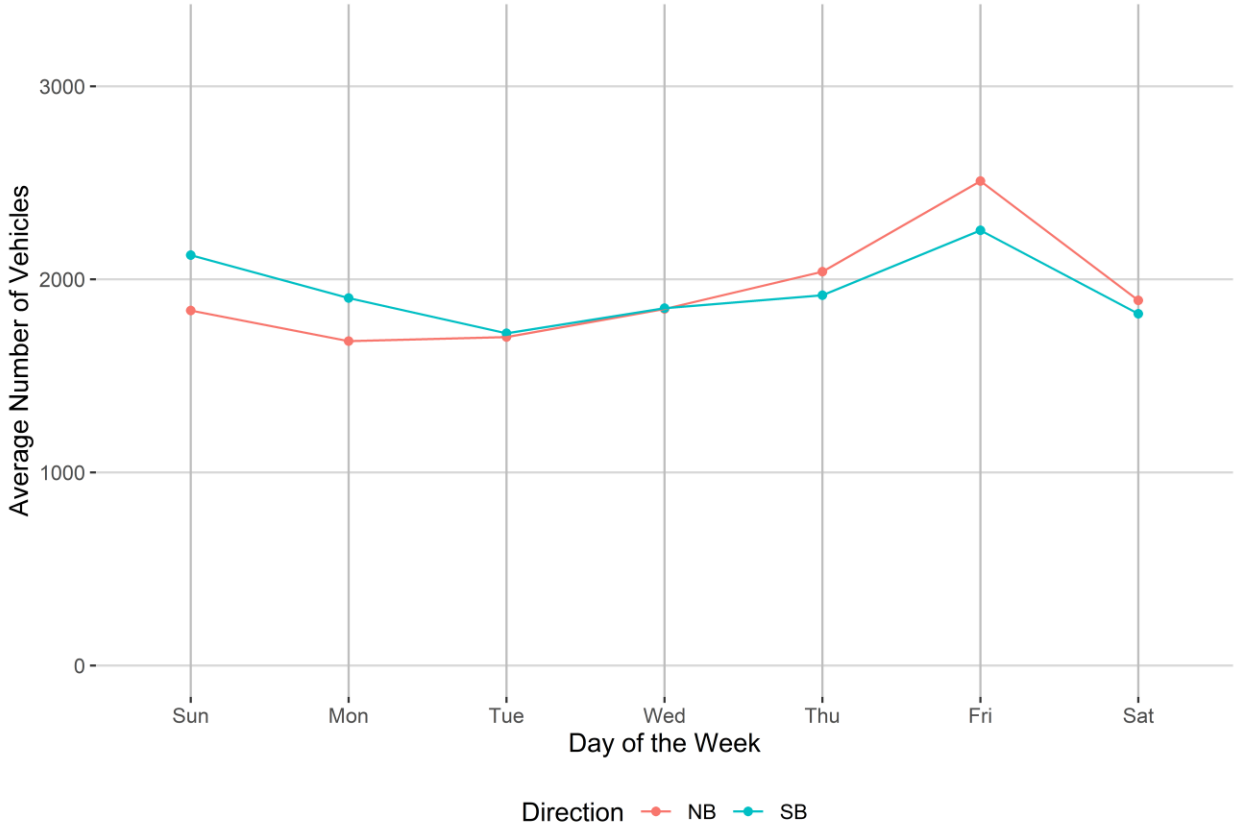


Figure 3 - Average Overweight Vehicle Volume
vs. Day of the Week

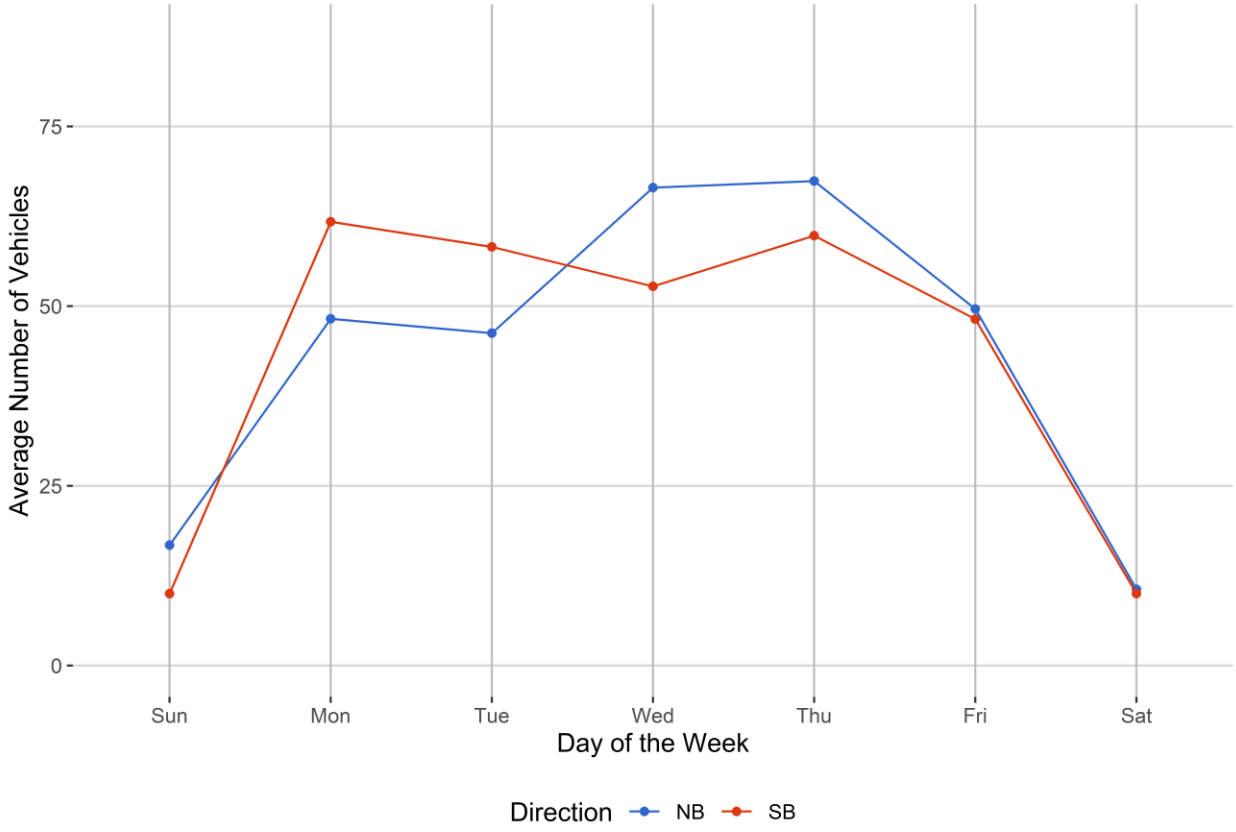


Figure 4 - Passenger Vehicles
vs. Hour of the Day

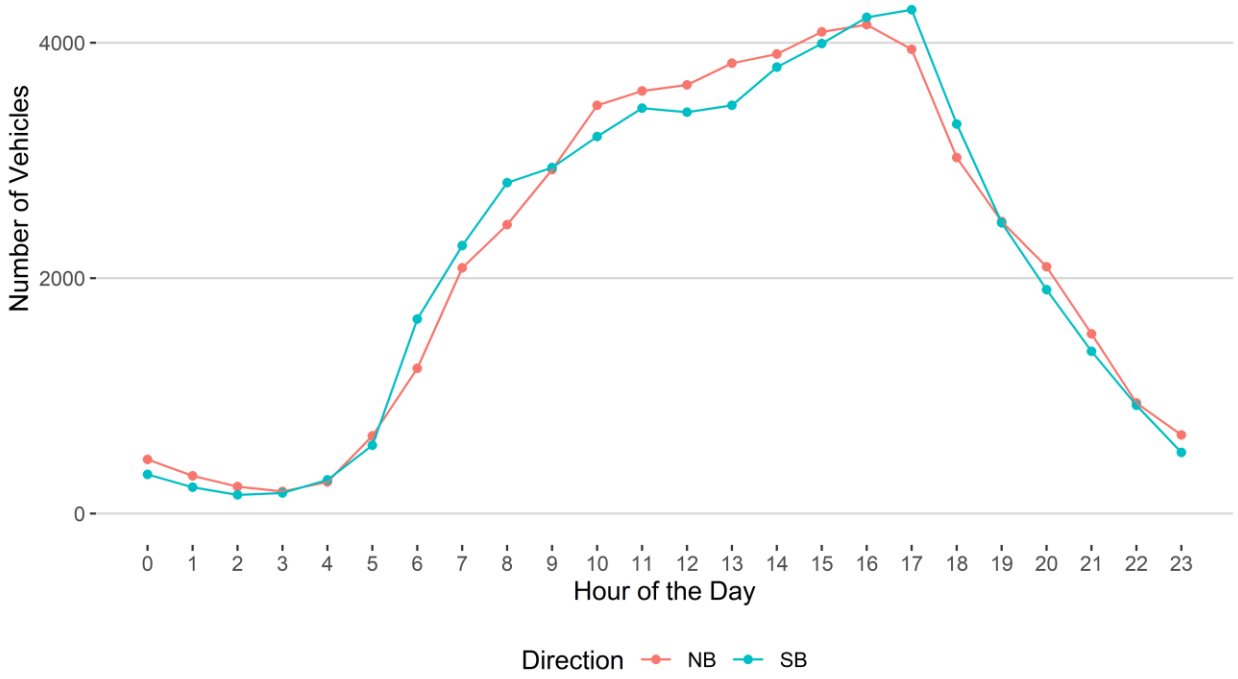


Figure 5 - Heavy Commercial Vehicles
vs. Hour of the Day

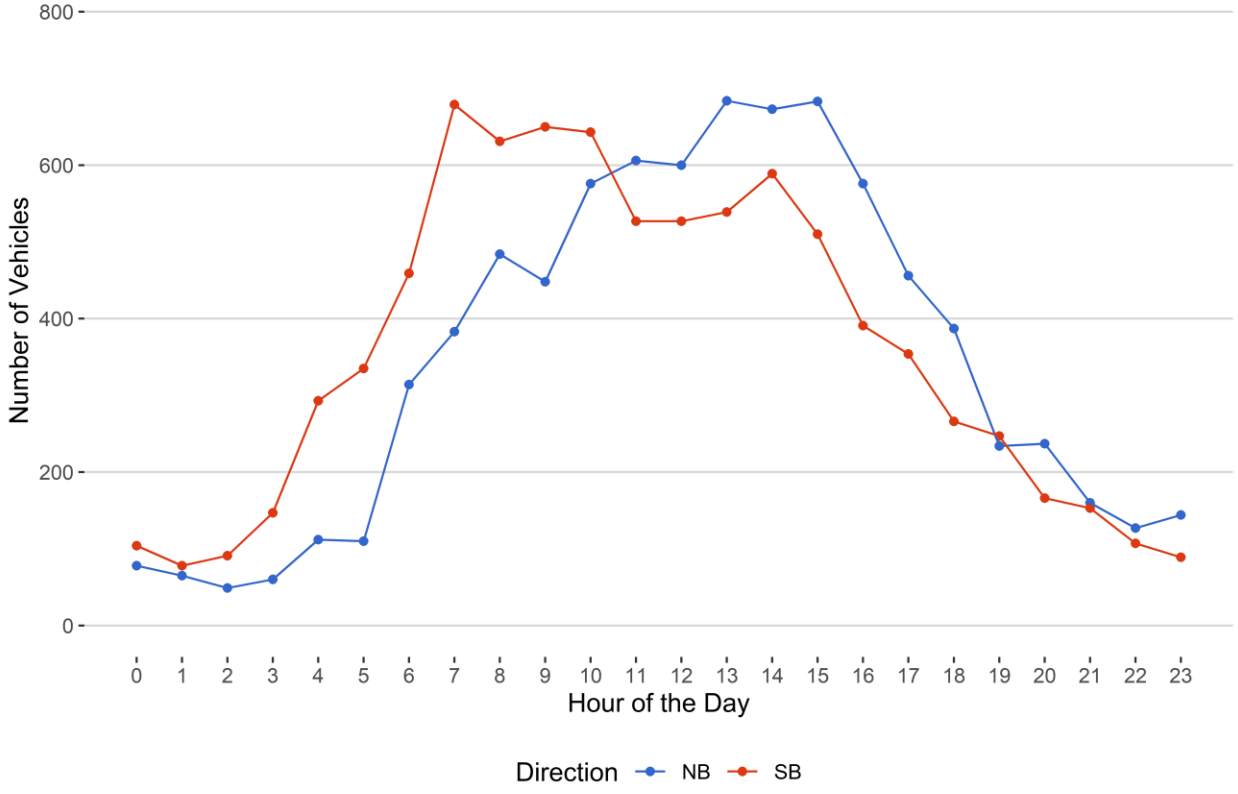


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

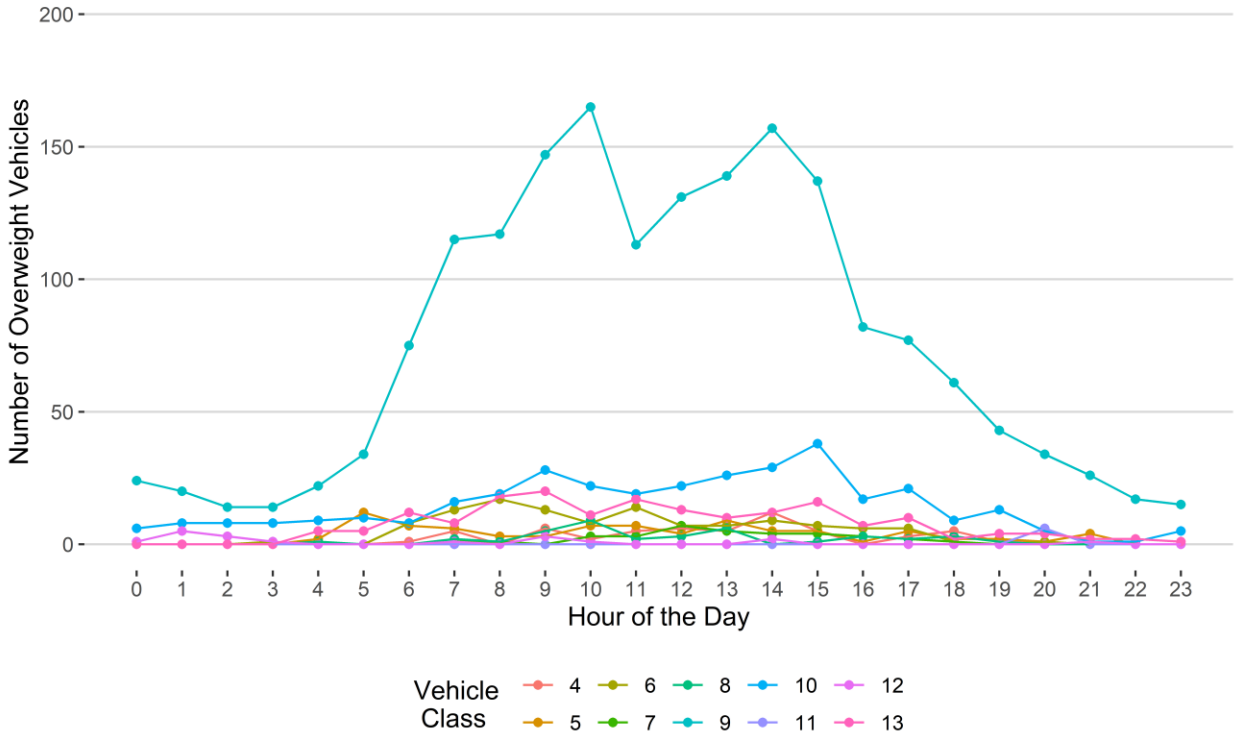


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

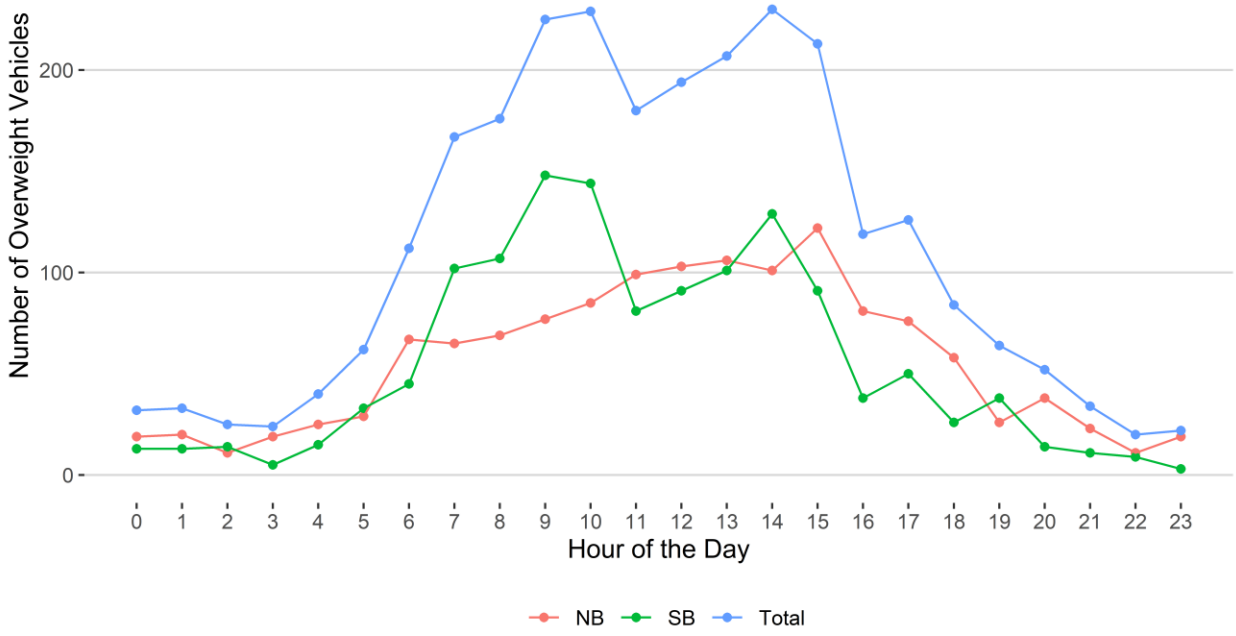
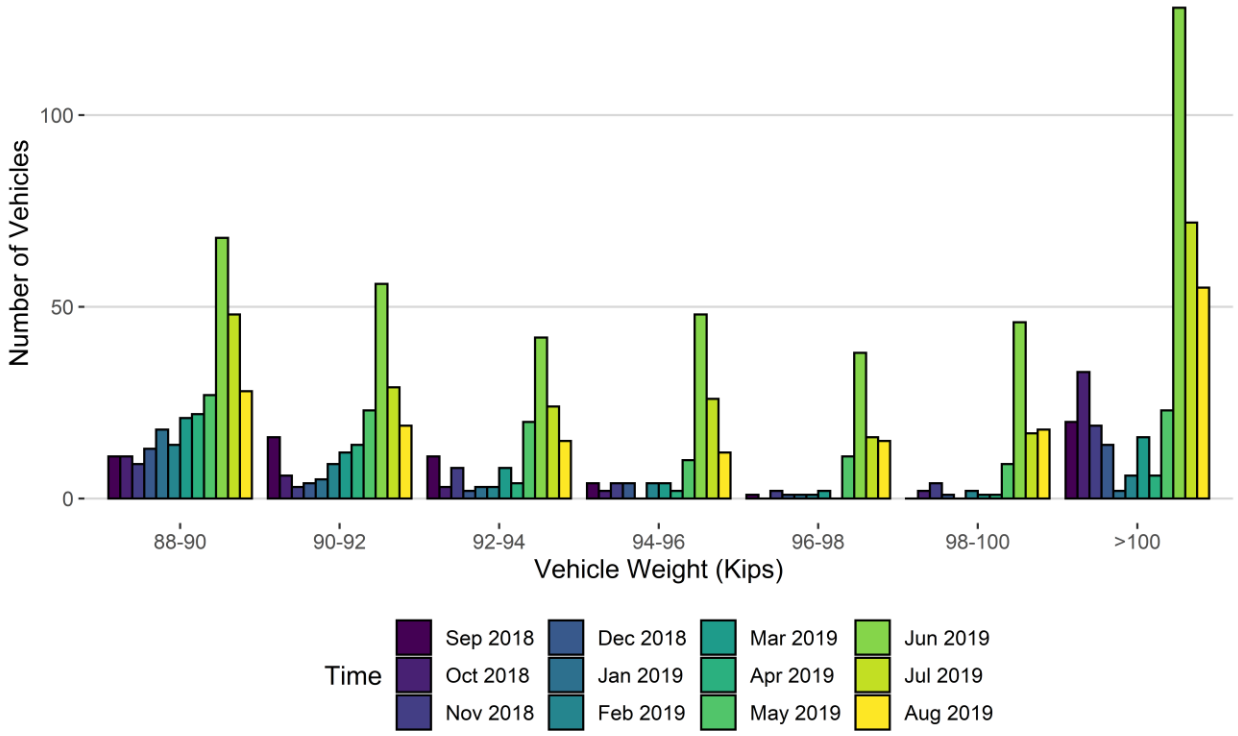
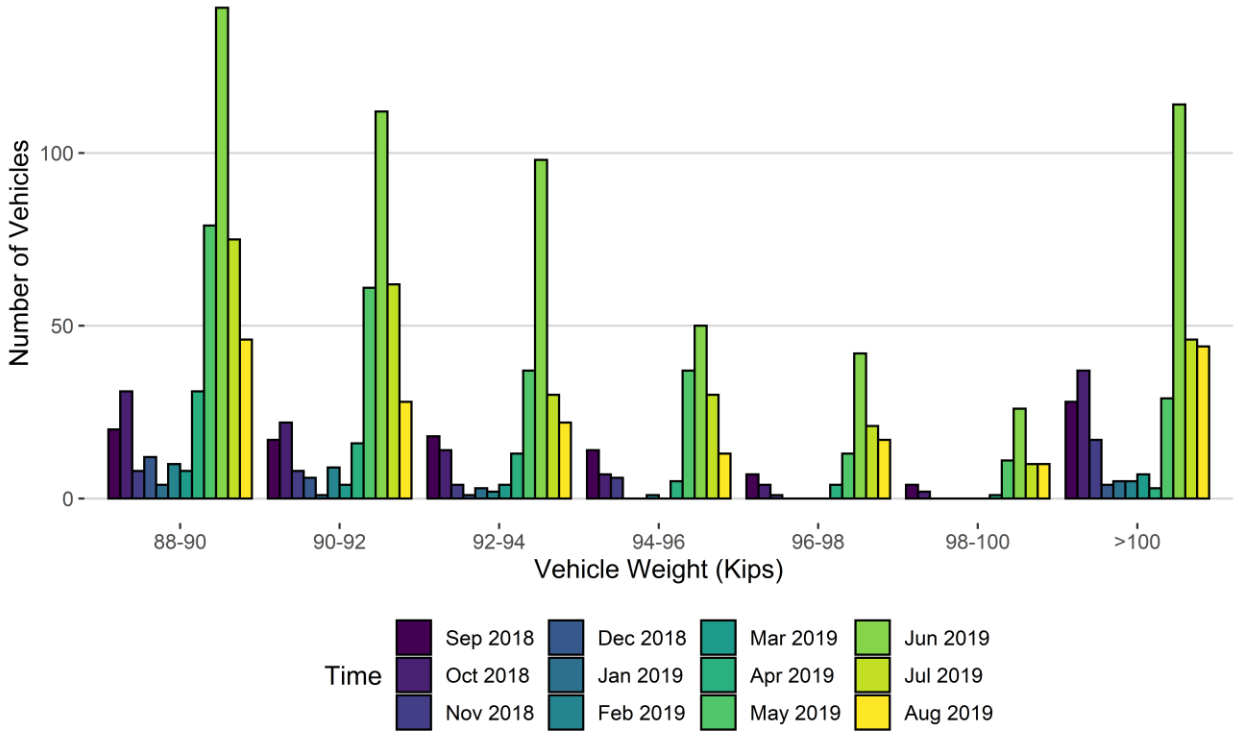


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*	*Jul 2019*	*Aug 2019*
88-90	11	11	9	13	18	14	21	22	27	68	48	28
90-92	16	6	3	4	5	9	12	14	23	56	29	19
92-94	11	3	8	2	3	3	8	4	20	42	24	15
94-96	4	2	4	4	0	4	4	2	10	48	26	12
96-98	1	0	2	1	1	1	2	0	11	38	16	15
98-100	0	2	4	1	0	2	1	1	9	46	17	18
>100	20	33	19	14	2	6	16	6	23	128	72	55
Total	63	57	49	39	29	39	64	49	123	426	232	162

Figure 8 - Histogram of SB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*	*Jul 2019*	*Aug 2019*
88-90	20	31	8	12	4	10	8	31	79	142	75	46
90-92	17	22	8	6	1	9	4	16	61	112	62	28
92-94	18	14	4	1	3	2	4	13	37	98	30	22
94-96	14	7	6	0	0	1	0	5	37	50	30	13
96-98	7	4	1	0	0	0	0	4	13	42	21	17
98-100	4	2	0	0	0	0	0	1	11	26	10	10
>100	28	37	17	4	5	5	7	3	29	114	46	44
Total	108	117	44	23	13	27	23	73	267	584	274	180

Figure 8 - Class 9's and 10's by Direction vs Gross Vehicle Weight

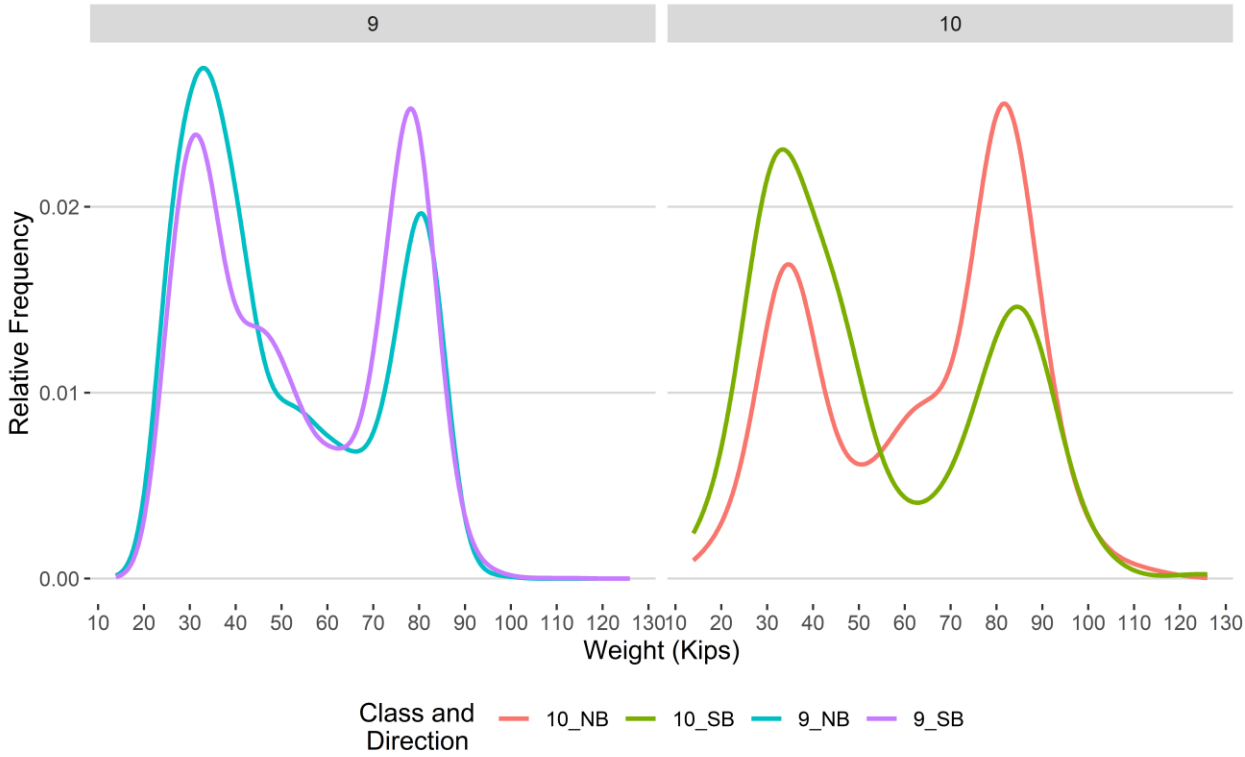


Figure 9 - Freight Percentage by Direction and Class

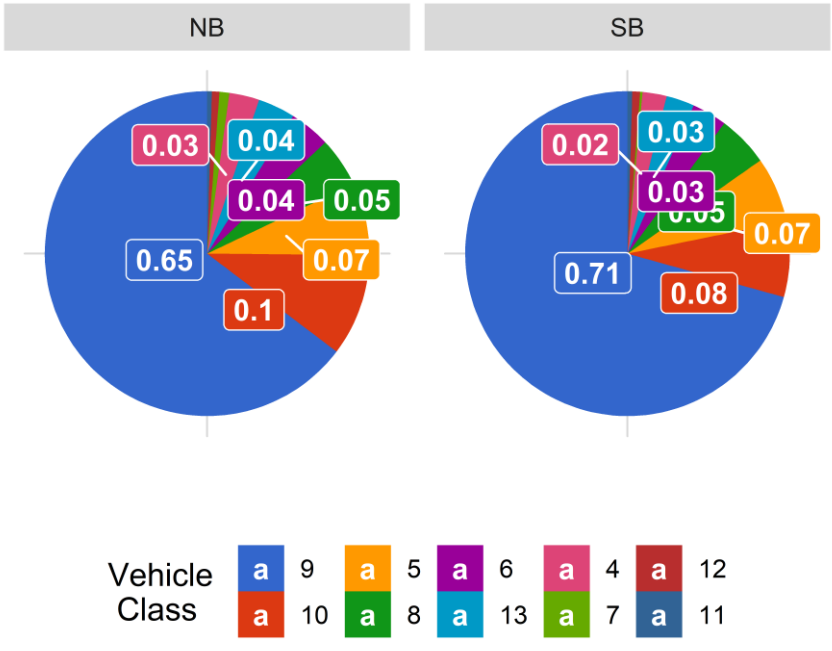


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

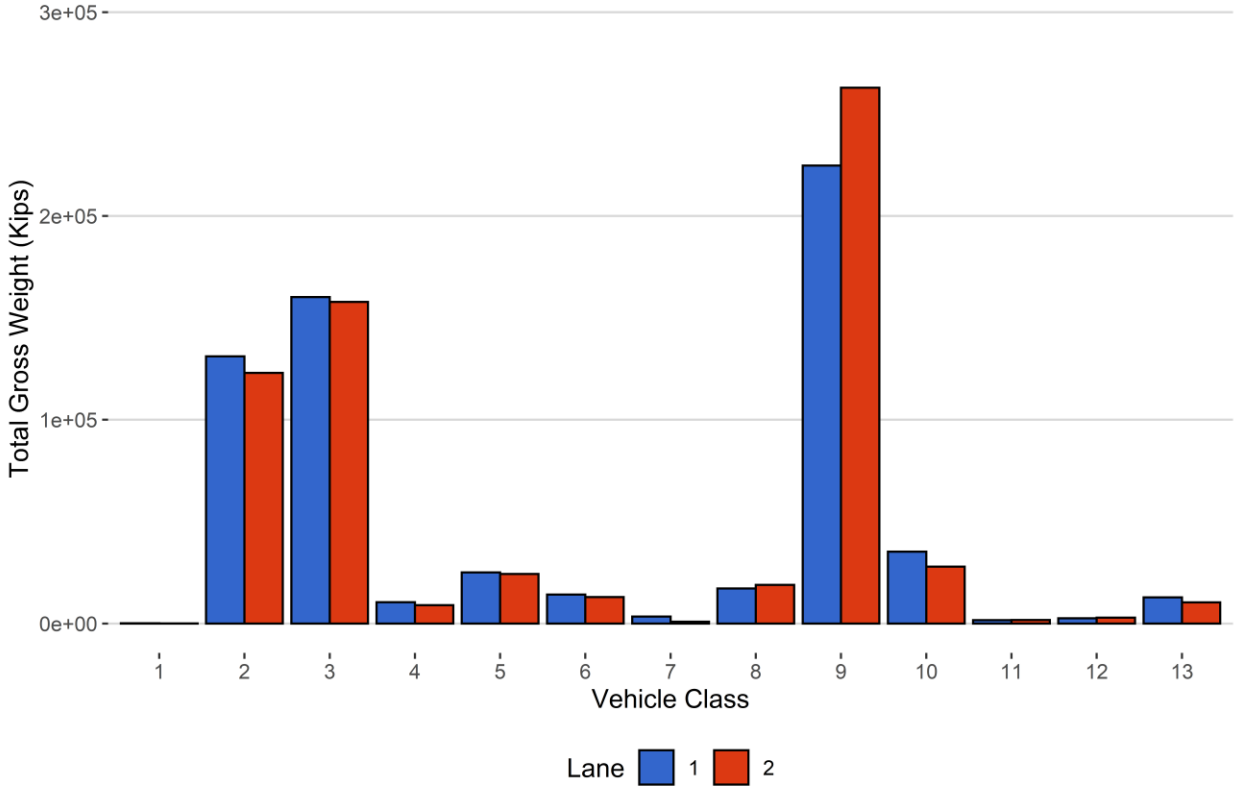


Figure 11 - Total Gross Vehicle Weight

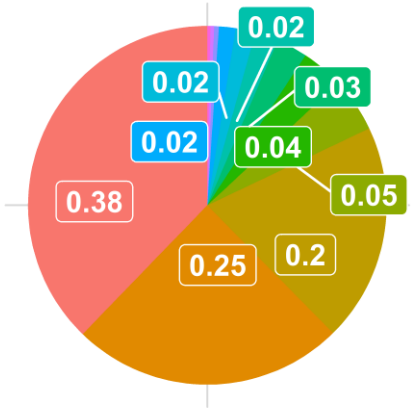


Figure 12 - Total ESALs by Class and Lane

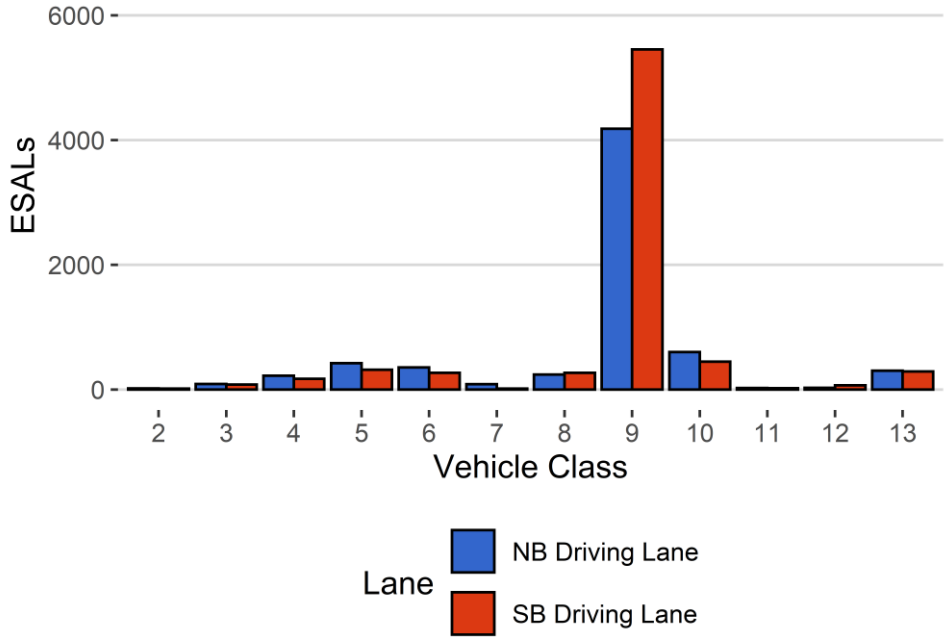


Figure 13 - ESALs by Class

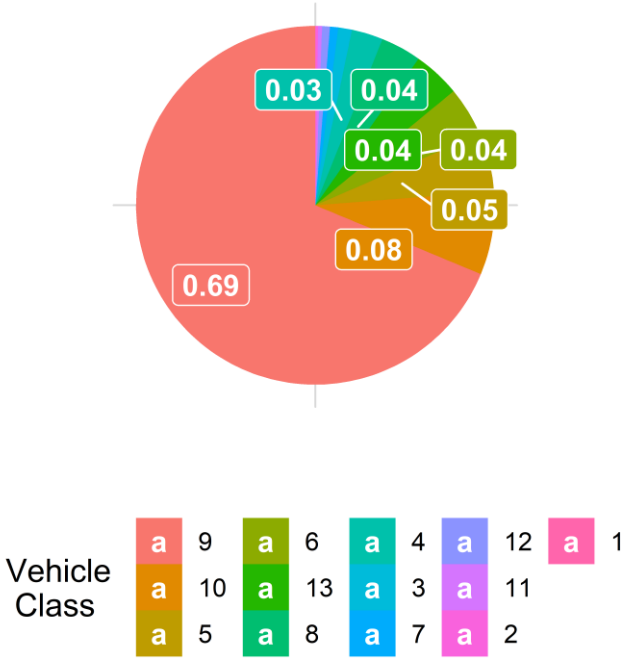


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*
June 2019	11.02	0.00	11.18	0.00
July 2019	11.10	0.69	11.36	1.61
August 2019	11.09	0.64	11.19	0.17

Table 2 Vehicle Classification Data

Vehicle Class	*Monthly Average Daily Volume*	*Monthly Total Volume*	*Monthly Total Volume Percentage*	*Monthly Total Overweight Vehicles*	*Monthly Total Overweight Percentage*
1	3	98	0.1	0	0
2	1971	61104	49.7	0	0
3	1437	44541	36.3	0	0
4	22	671	0.5	58	2.2
5	109	3391	2.8	85	3.2
6	28	873	0.7	118	4.4
7	3	79	0.1	34	1.3
8	38	1165	0.9	39	1.5
9	303	9398	7.7	1779	66.8
10	35	1091	0.9	348	13.1
11	3	90	0.1	6	0.2
12	3	92	0.1	18	0.7
13	8	236	0.2	179	6.7
TOTAL	**3962**	**122829**	**100**	**2664**	**100**

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-08-10	Saturday	05:33:19	10	NB	1	127.22
2019-08-26	Monday	18:03:14	10	SB	2	125.96
2019-08-11	Sunday	17:29:49	10	SB	2	123.04
2019-08-28	Wednesday	14:36:59	10	NB	1	116.25
2019-08-01	Thursday	14:14:47	9	SB	2	113.71
2019-08-27	Tuesday	20:42:10	10	NB	1	111.3
2019-08-16	Friday	09:19:42	10	NB	1	109.38
2019-08-16	Friday	09:20:06	10	NB	1	109.04
2019-08-27	Tuesday	09:45:21	9	SB	2	107.3
2019-08-23	Friday	01:31:46	10	NB	1	104.96

Table 4 Freight Summary

Vehicle Class	*Direction*	*Weight of Empty Vehicle (Kips)*	*Total Number of Vehicles*	*Number of Empty Vehicles*	*Percentage of Empty Vehicles*	*Total Weight of Vehicles with Freight (Kips)*	*Total Weight of Empty Vehicles (Kips)*	*Total Weight of Freight (Tons)*
4	NB	15	337	33	9.8	9986	434	2713
5	NB	8	1665	69	4.1	24577	514	5905
6	NB	19	430	60	14	13171	1015	3070
7	NB	11.5	61	0	0	3398	0	1348
8	NB	31	547	246	45	11565	5632	1117
9	NB	33	4426	1122	25.4	193059	31698	42013
10	NB	33.5	554	66	11.9	33345	1923	8499
11	NB	36.5	44	20	45.5	1218	437	171
12	NB	36.5	49	9	18.4	2340	238	440
13	NB	31.5	133	0	0	12853	0	4332
TOTAL	****	****	**8246**	**1625**	****	**305512**	****	**69608**
Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	SB	15	324	42	13	8409	558	2090
5	SB	8	1673	120	7.2	23419	890	5497
6	SB	19	429	76	17.7	11641	1319	2467
7	SB	11.5	17	0	0	867	0	336
8	SB	31	600	243	40.5	13777	5183	1355
9	SB	33	4826	1077	22.3	232080	30834	54182
10	SB	33.5	520	153	29.4	23504	4415	5605
11	SB	36.5	45	21	46.7	1299	461	212
12	SB	36.5	42	5	11.9	2761	124	705
13	SB	31.5	99	0	0	10398	0	3640
TOTAL	****	****	**8575**	**1737**	****	**328154**	****	**76087**
GRAND TOTAL	****	****	**16821**	**3362**	**363**	**633667**	**85674**	**145695**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*NB*	*SB*	*Total*	*Percentage*
1	89	49	139	0
2	131100	122953	254053	19.7
3	160157	157779	317936	24.6
4	10419	8967	19386	1.5
5	25091	24308	49400	3.8
6	14186	12960	27146	2.1
7	3398	867	4265	0.3
8	17197	18960	36157	2.8
9	224757	262914	487671	37.8
10	35268	27919	63187	4.9
11	1655	1760	3415	0.3
12	2577	2885	5462	0.4
13	12853	10398	23251	1.8
TOTAL	**638749**	**652720**	**1291468**	**100**
GVW/LANE	**49.46**	**50.54**	**100**	**0.01**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*NB*	*SB*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0.0103
2	18	16	34	0.2	0.0012
3	91	82	173	1.2	0.008
4	224	174	398	2.8	1.21
5	423	319	741	5.3	0.45
6	356	268	624	4.5	1.45
7	86	18	104	0.7	2.54
8	242	269	512	3.6	0.9
9	4182	5452	9634	68.7	2.09
10	604	448	1052	7.5	1.96
11	27	23	50	0.4	1.12
12	29	69	98	0.7	2.03
13	304	291	595	4.2	4.93
TOTAL	**6587**	**7429**	**14016**	**100**	**19**
ESALS/LANE	**47**	**53**	**100**	**–**	**–**

Table 7 Site Summary: Volume and Vehicle Class

Month	*Total Volume*	*Monthly ADT*	*Monthly HCADT*	*Passenger Vehicles*	*Passenger Vehicles %*	*Heavy Commercial Vehicles*	*Heavy Commercial Vehicles %*
Sep 2018	104355	3478	463	90479	86.7	13875.8	13.3
Oct 2018	108346	3495	550	91301	84.3	17045.5	15.7
Nov 2018	100582	3353	542	84315	83.8	16266.5	16.2
Dec 2018	89419	2884	461	75130	84	14289	16
Jan 2019	82665	2667	496	67282	81.4	15383.3	18.6
Feb 2019	69157	2470	423	57312	82.9	11844.7	17.1
Mar 2019	88959	2870	393	76774	86.3	12184.6	13.7
Apr 2019	93990	3133	460	80204	85.3	13785.9	14.7
May 2019	114550	3636	595	96108	83.9	18442.1	16.1
Jun 2019	112977	3766	550	96463	85.4	16514	14.6
Jul 2019	117623	3815	556	100380	85.3	17243.1	14.7
Aug 2019	122829	3935	551	105743	86.1	17085.9	13.9
TOTAL	**1205452**	**–**	**–**	**1021491**	**–**	**183960**	**–**
AVERAGE	**100454**	**3292**	**503**	**85124**	**85**	**15330**	**15**

###ESALs

Month	*ESALS NB Driving Lane*	*ESALS SB Driving Lane*	*Total ESALS*	*Pavement Life Decrease Months*
Sep 2018	4097	5652	9749	5.7
Oct 2018	4788	6405	11193	3.8
Nov 2018	4625	5107	9731	3.1
Dec 2018	4765	3913	8678	0.9
Jan 2019	4624	5069	9694	0.5
Feb 2019	3033	3535	6568	1.1
Mar 2019	3076	3597	6674	1.4
Apr 2019	3287	4734	8021	3.5
May 2019	5574	8427	14001	11.1
Jun 2019	15188	14413	29601	9.3
Jul 2019	6532	8499	15031	12.1
Aug 2019	7374	7666	15040	9.4
TOTAL	**66963**	**–**	**–**	**–**
AVERAGE	**5580**	**6418**	**11998**	**5**

###Gross Vehicle Weight

Month	*GVW NB Driving Lane*	*GVW SB Driving Lane*	*Total GVW Kips*
Sep 18	502142	546473	1048616
Oct 18	543677	598248	1141925

Nov 18	532437	542085	1074522
Dec 18	495872	461558	957430
Jan 19	473918	463320	937238
Feb 19	358035	373880	731916
Mar 19	406564	415689	822254
Apr 19	442890	492577	935467
May 19	590185	669683	1259868
Jun 19	1226663	1231162	2457825
Jul 19	622251	671633	1293884
Aug 19	639515	653216	1292731
TOTAL	**6834152**	**7119523**	**13953675**
AVERAGE	**569513**	**593294**	**1162806**

###Overweight Vehicles

Month	*Total Number of Overweight Vehicles*	*Overweight / Total Volume*	*Overweight / Heavy Commercial Volume*	*Number Over 88,000 lbs*	*Number Over 98,000 lbs*
Sep 2018	1177	1.1	8.5	171	52
Oct 2018	1281	1.2	7.5	177	77
Nov 2018	901	0.9	5.6	94	40
Dec 2018	880	1	6.2	62	19
Jan 2019	724	0.9	4.8	44	8
Feb 2019	613	0.9	5.3	67	14
Mar 2019	509	0.6	4.2	87	24
Apr 2019	661	0.7	4.9	122	11
May 2019	2320	2.1	12.7	393	73
Jun 2019	5748	2.6	17.6	1016	320
Jul 2019	3049	2.6	17.9	506	145
Aug 2019	2670	2.2	15.8	344	129
TOTAL	**20533**	**–**	**–**	**3083**	**912**
AVERAGE	**1711.1**	**1.4**	**9.2**	**256.9**	**76**

###Freight

Month	*NB Freight Tons*	*SB Freight Tons*	*Total Freight*	*NB Freight %*	*SB Freight %*
Sep 2018	49651	61569	111220	44.6	55.4
Oct 2018	55838	73026	128864	43.3	56.7
Nov 2018	60616	62469	123084	49.2	50.8
Dec 2018	63052	47873	110925	56.8	43.2
Jan 2019	60151	52807	112959	53.3	46.7
Feb 2019	36834	46586	83420	44.2	55.8
Mar 2019	38786	43303	82089	47.2	52.8

Apr 2019	43211	58172	101383	42.6	57.4
May 2019	62585	91602	154187	40.6	59.4
Jun 2019	149121	146296	295417	50.5	49.5
Jul 2019	67865	85955	153821	44.1	55.9
Aug 2019	69608	76087	145695	47.8	52.2
TOTAL	**757319**	**845746**	**1603065**	**–**	**–**
AVERAGE	**63109.9**	**70478.8**	**133588.8**	**47**	**53**